



US006388955B1

(12) **United States Patent**
Takagi et al.

(10) Patent No.: **US 6,388,955 B1**

(45) Date of Patent: **May 14, 2002**

(54) **REPRODUCING METHOD FOR
MAGNETO-OPTIC RECORDING MEDIUM,
AND MAGNETO-OPTIC DISK DEVICE**

6,205,092 B1 • 3/2001 Yamaguchi et al. 369/13

6,226,234 B1 • 5/2001 Ohnuki et al. 369/13

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(75) Inventors: Naoyuki Takagi; Atsushi Yamaguchi;
Kenichiro Mitani, all of Moriguchi
(JP)

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JP	10-289487	10/1998
JP	11176036	7/1999

(73) Assignee: Sanyo Electric Co., Ltd., Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: 09/381,498

(22) PCT Filed: Jan. 21, 1999

(86) PCT No.: PCT/JP99/00207

§ 371 Date: Sep. 22, 1999

§ 102(e) Date: Sep. 22, 1999

(87) PCT Pub. No.: WO99/38161

PCT Pub. Date: Jul. 29, 1999

(30) **Foreign Application Priority Data**

Jan. 23, 1998 (JP) 10-011341

Nov. 13, 1998 (JP) 10-323842

(51) Int. Cl.⁷ G11B 11/00

(52) U.S. Cl. 369/13.09; 369/13.26

(58) Field of Search 369/13, 14, 110.1;
360/59, 116

(56) **References Cited**

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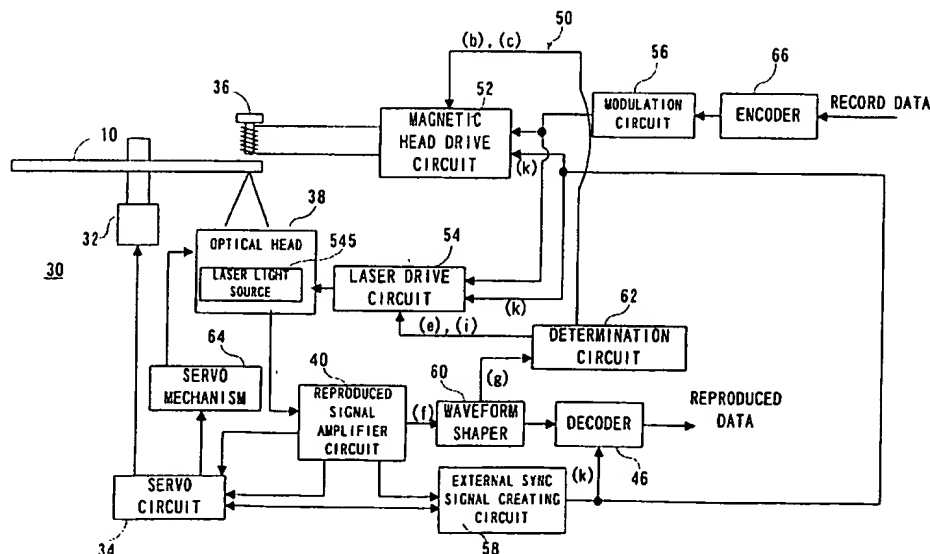
Primary Examiner—Tan Dinh

(74) Attorney, Agent, or Firm—Armstrong, Westerman &
Hattori, LLP

(57) **ABSTRACT**

A reproducing apparatus reproduces a signal recorded in a magneto-optical disk. The magneto-optical disk includes a layered structure having a recording layer, an intermediate layer and a reproducing layer. Laser light is illuminated from an optical head to the magneto-optical disk in such an intensity that no magnetic domain is transferred from the recording layer to the reproducing layer only by the laser light. In this state, alternating magnetic field is applied through a magnetic head to the magneto-optical disk, thereby concurrently causing transfer and expansion of a magnetic domain to the reproducing layer. As a result, transfer of the magnetic domain is effected with expansion.

10 Claims, 24 Drawing Sheets





US006650599B2

(12) **United States Patent**
Takagi et al.

(10) Patent No.: **US 6,650,599 B2**

(45) Date of Patent: **Nov. 18, 2003**

(54) **METHOD AND APPARATUS FOR
DETERMINING POWER LEVEL OF LASER
BEAM IN MAGNETO-OPTICAL
RECORDING DEVICE**

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(75) Inventors: Naoyuki Takagi, Moriguchi (JP);
Atsushi Yamaguchi, Moriguchi (JP);
Kenichiro Mitani, Moriguchi (JP)

FOREIGN PATENT DOCUMENTS

(73) Assignee: Sanyo Electric Co., Ltd., Moriguchi
(JP)

EP	0318925 A2	6/1989
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JP	5-144106	6/1993
JP	8-7350	1/1996
JP	WO98/02877	1/1998
JP	10-289497	10/1998
JP	11176036	7/1999

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 1 day.

(21) Appl. No.: 09/922,836

* cited by examiner

(22) Filed: Aug. 7, 2001

(65) **Prior Publication Data**

US 2002/0027835 A1 Mar. 7, 2002

Primary Examiner—Tan Dinh

(74) Attorney, Agent, or Firm—Armstrong, Westerman &
Hattori, LLP

Related U.S. Application Data

(62) Division of application No. 09/381,498, filed as application
No. PCT/JP99/00207 on Jan. 21, 1999, now Pat. No. 6,388,
955.

(30) **Foreign Application Priority Data**

Jan. 23, 1998 (JP) 10-011341
Nov. 13, 1998 (JP) 10-323842

(51) Int. Cl.⁷ G11B 11/00

(52) U.S. Cl. 369/13.27; 369/13.09

(58) Field of Search 369/13.27, 13.26,
369/13.05, 13.06, 13.14, 13.02, 13.09

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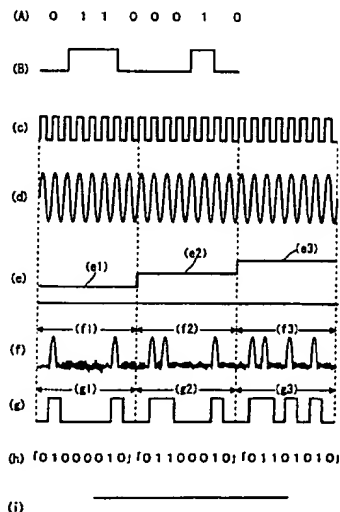
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(57) **ABSTRACT**

A reproducing apparatus reproduces a signal recorded in a magneto-optical disk. The magneto-optical disk includes a layered structure having a recording layer, an intermediate layer and a reproducing layer. Laser light is illuminated from an optical head to the magneto-optical disk in such an intensity that no magnetic domain is transferred from the recording layer to the reproducing layer only by the laser light. In this state, alternating magnetic field is applied through a magnetic head to the magneto-optical disk, thereby concurrently causing transfer and expansion of a magnetic domain to the reproducing layer. As a result, transfer of the magnetic domain is effected with expansion.

11 Claims, 24 Drawing Sheets





US006501707B1

(12) **United States Patent**
Yamaguchi et al.

(10) Patent No.: **US 6,501,707 B1**
(45) Date of Patent: **Dec. 31, 2002**

(54) **METHOD AND APPARATUS FOR RECORDING WITH A MAGNETO-OPTICAL RECORDING MEDIUM APPLYING ONE PERIOD OF AN ALTERNATING MAGNETIC FIELD TO A UNIT DOMAIN LENGTH**

(75) Inventors: Atsushi Yamaguchi, Ogaki (JP);
Naoyuki Takagi, Fuwa-gun (JP)

(73) Assignee: Sanyo Electric Co., Ltd., Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 09/233,917

(22) Filed: Jan. 21, 1999

(30) Foreign Application Priority Data

Jan. 23, 1998 (JP) 10-011340

(51) Int. Cl.⁷ G11B 11/00

(52) U.S. Cl. 369/13.1; 369/47.28

(58) Field of Search 369/13, 14, 275.2,
369/122, 47.28, 47.5, 13.07, 275.3, 116,
288, 13.1, 53.34, 13.01, 47.35

(56) References Cited

U.S. PATENT DOCUMENTS

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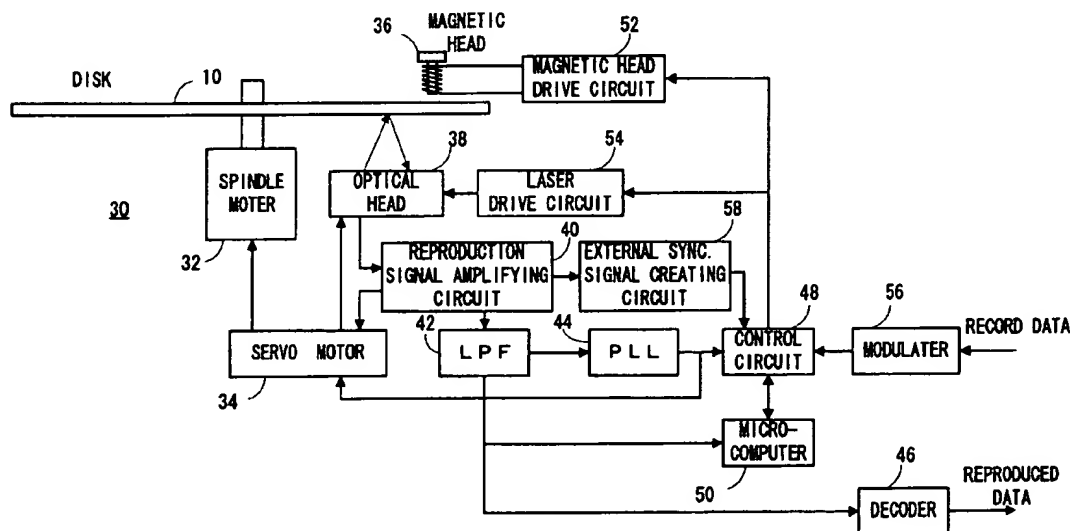
Primary Examiner—Ali Neyzari

(74) Attorney, Agent, or Firm—Armstrong, Westerman & Hattori, LLP

(57) **ABSTRACT**

A magneto-optical recording medium includes a recording layer and a reproducing layer respectively formed by magnetic layers on a substrate. A record magnetic domain is formed within the recording layer by using a magnetic head, which is transferred into a reproducing layer by irradiating a laser beam upon reproduction. The physical length in recording a unit bit is taken as a unit domain length. Where the unit domain length is 1T and "1" is recorded in 1T, "1" is recorded in a former half 1T/2 and "0" is in a latter half 1T/2 by applying one period of an alternating magnetic field to the unit domain length.

6 Claims, 11 Drawing Sheets





US006697304B2

(12) **United States Patent**
Yamaguchi et al.

(10) Patent No.: **US 6,697,304 B2**
(45) Date of Patent: **Feb. 24, 2004**

(54) **METHOD AND APPARATUS FOR RECORDING WITH A MAGNETO-OPTICAL RECORDING MEDIUM**

(75) Inventors: Atsushi Yamaguchi, Ogaki (JP); Naoyuki Takagi, Gifu (JP)

(73) Assignee: Sanyo Electric Co., Ltd., Moriguchi (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 10/247,691

(22) Filed: Sep. 20, 2002

(65) **Prior Publication Data**

US 2003/0021192 A1 Jan. 30, 2003

Related U.S. Application Data

(62) Division of application No. 09/233,917, filed on Jan. 21, 1999, now Pat. No. 6,501,707.

(30) **Foreign Application Priority Data**

Jan. 23, 1998 (JP) 10-11340

(51) Int. Cl.⁷ G11B 11/00

(52) U.S. Cl. 369/13.1; 369/13.54

(58) Field of Search 369/13.1, 13.41, 369/47.28, 14, 275.2, 122, 47.5, 53.34, 13.01, 47.35, 13.15, 13.17, 13.54, 116, 59.24, 13.02

(56) **References Cited**

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6,246,640 B1 6/2001 Shimazaki et al. 369/13.1

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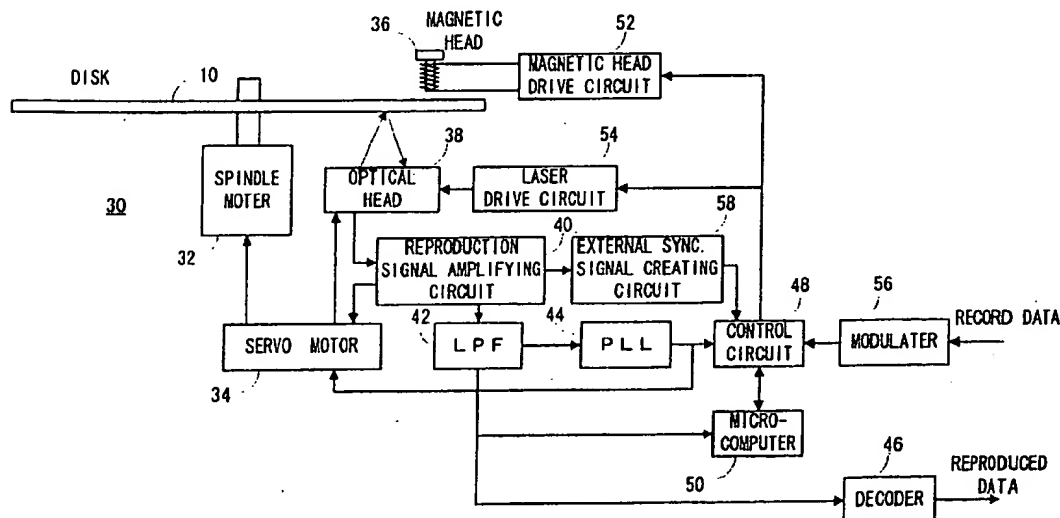
Primary Examiner—Ali Neyzari

(74) Attorney, Agent, or Firm—Westerman, Hattori, Daniels & Adrian, LLP

(57) **ABSTRACT**

A magneto-optical recording medium includes a recording layer and a reproducing layer respectively formed by magnetic layers on a substrate. A record magnetic domain is formed within the recording layer by using a magnetic head, which is transferred into a reproducing layer by irradiating a laser beam upon reproduction. The physical length in recording a unit bit is taken as a unit domain length. Where the unit domain length is 1T and "1" is recorded in 1T, "1" is recorded in a former half 1T/2 and "0" is in a latter half 1T/2 by applying one period of an alternating magnetic field to the unit domain length.

1 Claim, 11 Drawing Sheets



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2	0	((magneto adj optic\$) and recording and (magnetic adj domain)) and (recoridng adj layer) and ((reproducing or playback) adj layer)	USPAT; EPO; JPO	2004/04/27 16:37
3	220	((magneto adj optic\$) and recording and (magnetic adj domain)) and (recording adj layer) and ((reproducing or playback) adj layer)	USPAT; EPO; JPO	2004/04/27 16:37
4	13194	((magneto adj optic\$) and recording and (magnetic adj domain)) and (recording adj layer) and ((reproducing or playback) adj layer)) and laser nad temperature and enlarge\$ and calibration	USPAT; EPO; JPO	2004/04/27 16:39
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6	4	((magneto adj optic\$) and recording and (magnetic adj domain)) and (recording adj layer) and ((reproducing or playback) adj layer)) and laser and temperature and calibration	USPAT; EPO; JPO	2004/04/27 16:40

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1	<input type="checkbox"/>	<input type="checkbox"/>	US 6301199 B1	20011009	16

	Title	Current OR	Current XRef
1	Magneto-optical recording medium and recording/reproducing apparatus therefor in which recorded magnetic domains are transferred from the recording layer to the reproducing layer	369/13.01	369/53.2

	Retrieval Classif	Inventor	S	C	P	2	3	4	5
1		Yamaguchi, Atsushi et al.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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1	<input type="checkbox"/>	<input type="checkbox"/>	US 6650599 B2	20031118	36
2	<input type="checkbox"/>	<input type="checkbox"/>	US 6538968 B1	20030325	46
3	<input type="checkbox"/>	<input checked="" type="checkbox"/>	US 6388955 B1	20020514	35
4	<input type="checkbox"/>	<input type="checkbox"/>	US 6301199 B1	20011009	16

	Title	Current OR	Current XRef
1	Method and apparatus for determining power level of laser beam in magneto-optical recording device	369/13.27	369/13.09
2	Information recording/reproducing apparatus	369/47.53	369/53.26
3	Reproducing method for magneto-optic recording medium, and magneto-optic disk device	369/13.09	369/13.26
4	Magneto-optical recording medium and recording/reproducing apparatus therefor in which recorded magnetic domains are transferred from the recording layer to the reproducing layer	369/13.01	369/53.2

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1		Takagi, Naoyuki et al.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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5	<input type="checkbox"/>	<input type="checkbox"/>	US 5986977 A	19991116	31

	Title	Current OR	Current XRef
1	Method of reading magneto-optical recording medium	369/13.07	428/694ML
2	Recording method for a magneto-optical recording medium for position adjustment of a magnetic head	369/13.27	369/116; 369/13.47
3	Position adjustment method of a magnetic head using magneto-optical recording medium, and optical recording medium	369/13.12	369/116; 428/694EC
4	Method for reading magnetic super resolution type magneto-optical recording medium	369/13.05	369/116
5	Method for reading magnetic super resolution type magneto-optical recording medium	369/13.06	369/116

	Retrieval Classif	Inventor	S	C	P	2	3	4	5
1		Birukawa, Masahiro et al.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2		Birukawa, Masahiro et al.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Time: 16:58:45


PALM INTRANET

Inventor Name Search Result

Your Search was:

Last Name = YAMAGUCHI

First Name = ATSUSHI

Application#	Patent#	Status	Date Filed	Title	Inventor Name 51
<u>29127754</u>	D452758	150	08/14/2000	VACUUM CLEANER	YAMAGUCHI, ATSUSHI
<u>10759191</u>	Not Issued	020	01/20/2004	METHOD OF SOLDERING LEAD-FREE SOLDER, AND JOINED OBJECT SOLDERED BY THE SOLDERING METHOD	YAMAGUCHI, ATSUSHI
<u>10730981</u>	Not Issued	020	12/10/2003	OPTICAL RECORDING MEDIUM, OPTICAL RECORDING MEDIUM PRODUCING APPARATUS AND OPTICAL RECORDING MEDIUM PRODUCING METHOD	YAMAGUCHI, ATSUSHI
<u>10701077</u>	Not Issued	020	11/05/2003	INFORMATION RECORDING MEDIUM	YAMAGUCHI, ATSUSHI
<u>10698422</u>	Not Issued	020	11/03/2003	RECORDING MEDIUM AND APPARATUS AND METHOD FOR MANUFACTURING THE SAME	YAMAGUCHI, ATSUSHI
<u>10668355</u>	Not Issued	030	09/24/2003	PROCESS AND APPARATUS FOR FLOW SOLDERING	YAMAGUCHI, ATSUSHI
<u>10636623</u>	Not Issued	020	08/08/2003	ELECTRONIC CIRCUIT DEVICE INCLUDING HEAT- GENERATING ELEMENT MOUNTED ON CIRCUIT BOARD	YAMAGUCHI, ATSUSHI
<u>10327143</u>	Not Issued	041	12/23/2002	PROCESS FOR SOLDERING AND CONNECTING STRUCTURE	YAMAGUCHI, ATSUSHI
<u>10325888</u>	Not Issued	041	12/23/2002	PROCESS FOR SOLDERING AND CONNECTING STRUCTURE	YAMAGUCHI, ATSUSHI
<u>10302866</u>	Not	071	11/25/2002	MAGNETO-OPTICAL	YAMAGUCHI,

	Issued			RECORDING MEDIUM HAVING DIFFERENT MAGNETIC DOMAIN RADII IN RECORDING LAYER AND REPRODUCTION LAYER	ATSUSHI
<u>10247691</u>	<u>6697304</u>	150	09/20/2002	METHOD AND APPARATUS FOR RECORDING WITH A MAGNETO-OPTICAL RECORDING MEDIUM	YAMAGUCHI, ATSUSHI
<u>10237077</u>	<u>6635905</u>	150	09/09/2002	GALLIUM NITRIDE BASED COMPOUND SEMICONDUCTOR LIGHT-EMITTING DEVICE	YAMAGUCHI, ATSUSHI
<u>10235518</u>	Not Issued	030	09/04/2002	ANTI-BONDING AGENTS AND METHODS FOR BLAST FURNACE SLAG OR ITS GRADING ADJUSTED SLAG	YAMAGUCHI, ATSUSHI
<u>10139377</u>	Not Issued	061	05/07/2002	SOFT MAGNETIC THIN FILM AND THIN FILM MAGNETIC HEAD USING THE SAME	YAMAGUCHI, ATSUSHI
<u>10130534</u>	Not Issued	071	05/17/2002	SOLDER MATERIAL AND ELECTRIC OR ELECTRONIC DEVICE IN WHICH THE SAME IS USED	YAMAGUCHI, ATSUSHI
<u>10022228</u>	<u>6710850</u>	150	12/20/2001	EXPOSURE APPARATUS AND EXPOSURE METHOD	YAMAGUCHI, ATSUSHI
<u>10009168</u>	<u>6702175</u>	150	12/07/2001	METHOD OF SOLDERING USING LEAD-FREE SOLDER AND BONDED ARTICLEPREPARED THROUGH SOLDERING BY THE METHOD	YAMAGUCHI, ATSUSHI
<u>09983732</u>	Not Issued	030	10/25/2001	OPTICAL RECORDING MEDIUM, OPTICAL RECORDING MEDIUM MANUFACTURING APPARATUS, AND OPTICAL RECORDING MEDIUM MANUFACTURING METHOD	YAMAGUCHI, ATSUSHI
<u>09982811</u>	Not Issued	161	10/22/2001	MAGNETO-OPTICAL RECORDING MEDIUM HAVING DIFFERENT MAGNETIC DOMAIN RADII IN RECORDING LAYER AND REPRODUCTION LAYER	YAMAGUCHI, ATSUSHI
<u>09944186</u>	Not Issued	061	09/04/2001	NITRIDE BASED SEMICONDUCTOR LIGHT-EMITTING DEVICE	YAMAGUCHI, ATSUSHI

<u>09942871</u>	Not Issued	071	08/31/2001	THIN-FILM MAGNETIC HEAD AND METHOD OF MANUFACTURING SAME	YAMAGUCHI, ATSUSHI
<u>09942678</u>	Not Issued	092	08/31/2001	COBALT-NICKEL-IRON ALLOY THIN FILM AND METHOD OF FORMING THE SAME, AND THIN-FILM MAGNETIC HEAD AND METHOD OF MANUFACTURING THE SAME	YAMAGUCHI, ATSUSHI
<u>09931080</u>	Not Issued	030	08/17/2001	MAGNETO-OPTICAL RECORDING MEDIUM AND RECORDING/REPRODUCING APPARATUS THEREFOR	YAMAGUCHI, ATSUSHI
<u>09930286</u>	<u>6654203</u>	150	08/16/2001	THIN-FILM MAGNETIC HEAD AND METHOD OF MANUFACTURING SAME, HEAD GIMBAL ASSEMBLY AND HARD DISK DRIVE	YAMAGUCHI, ATSUSHI
<u>09924555</u>	<u>6648216</u>	150	08/09/2001	PROCESS AND APPARATUS FOR FLOW SOLDERING	YAMAGUCHI, ATSUSHI
<u>09923804</u>	<u>6687214</u>	150	08/08/2001	RECORDING MEDIUM AND APPARATUS AND METHOD FOR MANUFACTURING THE SAME	YAMAGUCHI, ATSUSHI
<u>09922836</u>	<u>6650599</u>	150	08/07/2001	MAGNETO-OPTICAL RECORDING MEDIUM REPRODUCING METHOD AND MAGNETO-OPTICAL DISK APPARATUS	YAMAGUCHI, ATSUSHI
<u>09911424</u>	Not Issued	071	07/25/2001	OPTICAL RECORDING MEDIUM HAVING A PLURALITY OF MEANDERING GROOVE TRACKS, OPTICAL RECORDING MEDIUM PRODUCING APPARATUS AND OPTICAL RECORDING MEDIUM PRODUCING METHOD	YAMAGUCHI, ATSUSHI
<u>09893731</u>	<u>6679430</u>	150	06/27/2001	RECORDING MEDIUM AND APPARATUS AND METHOD FOR MANUFACTURING THE SAME	YAMAGUCHI, ATSUSHI
<u>09889167</u>	Not Issued	041	07/11/2001	ARTICLE HAVING A CIRCUIT SOLDERED WITH PARTS AND METHOD FOR RECYCLING WASTES OF THE SAME	YAMAGUCHI, ATSUSHI
<u>09855753</u>	Not	041	05/16/2001	OPTICAL INFORMATION	YAMAGUCHI,

	Issued			RECORDING APPARATUS	ATSUSHI
<u>09855553</u>	Not Issued	161	05/16/2001	SOLDER, SOLDER PASTE AND SOLDERING METHOD	YAMAGUCHI, ATSUSHI
<u>09853158</u>	Not Issued	083	05/10/2001	THIN-FILM MAGNETIC HEAD A MAGNETISM INTERCEPTING LAYER PROVIDED BETWEEN READ HEAD AND WRITE HEAD	YAMAGUCHI, ATSUSHI
<u>09828987</u>	<u>6327232</u>	150	04/10/2001	INFORMATION RECORDING AND REPRODUCTION APPARATUS CARRYING OUT RECORDING AND REPRODUCTION OF INFORMATION USING LASER BEAM	YAMAGUCHI, ATSUSHI
<u>09828982</u>	<u>6314070</u>	150	04/10/2001	INFORMATION RECORDING AND REPRODUCTION APPARATUS CARRYING OUT RECORDING AND REPRODUCTION OF INFORMATION USING LASER BEAM	YAMAGUCHI, ATSUSHI
<u>09828935</u>	<u>6324137</u>	150	04/10/2001	INFORMATION RECORDING AND REPRODUCTION APPARATUS CARRYING OUT RECORDING AND REPRODUCTION OF INFORMATION USING LASER BEAM	YAMAGUCHI, ATSUSHI
<u>09818905</u>	<u>6428745</u>	150	03/28/2001	SOLDER, SOLDER PASTE AND SOLDERING METHOD	YAMAGUCHI, ATSUSHI
<u>09816754</u>	Not Issued	041	03/26/2001	NITRIDE BASED SEMICONDUCTOR PHOTO-LUMINESCENT DEVICE	YAMAGUCHI, ATSUSHI
<u>09810546</u>	<u>6642546</u>	150	03/19/2001	NITRIDE BASED SEMICONDUCTOR DEVICE AND METHOD OF FORMING THE SAME	YAMAGUCHI, ATSUSHI
<u>09803925</u>	Not Issued	161	03/13/2001	MAGNETIC HEAD CAPABLE OF CORRECTLY REPRODUCING SIGNAL BY DOMAIN ENLARGEMENT AND RECORDING/REPRODUCING APPARATUS EMPLOYING THE SAME	YAMAGUCHI, ATSUSHI
<u>09734729</u>	Not Issued	161	12/13/2000	MAGNETO-OPTICAL RECORDING AND	YAMAGUCHI, ATSUSHI

				REPRODUCING APPARATUS AND METHOD	
<u>09730068</u>	<u>6540798</u>	150	12/05/2000	METHOD OF PROCESSING SYNTHETIC RESINS INTO A FURNACE FUEL AND METHOD FOR BLOWING SYNTHETIC RESINS AS A FUEL INTO A FURNACE	YAMAGUCHI, ATSUSHI
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<u>09569064</u>	<u>6325279</u>	150	05/10/2000	SOLDER ALLOY OF ELECTRODE FOR JOINING ELECTRONIC PARTS AND SOLDERING METHOD	YAMAGUCHI, ATSUSHI
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